Supplementary materials

Table S1. Estimation for variables' regression coefficients (adjusted Beta) for case-fatality rate by proportion of aged above 65 years old

Variables	Beta (95% CI)	P-value
aged above 65 years old≤5% (n=75)		
GDP per capita (log)	-0.42 (-1.38, 0.54)	0.410
Population (log)	0.27 (-0.23, 0.77)	0.311
Population density (log)	-0.01 (-0.59, 0.57)	0.786
Stringency index	-0.04 (-0.11, 0.03)	0.366
Proportion of female smokers (log)	0.52 (-0.16, 1.19)	0.269
Proportion of male smokers	-0.02 (-0.09, 0.05)	0.480
CVD death rate (log)	-0.05 (-3.09, 2.98)	0.739
Diabetes prevalence (log)	-0.13 (-1.31, 1.06)	0.568
Testing policy		
0 (Ref)		
1	0.25 (-1.17, 1.66)	0.523
2	-1.07 (-2.92, 0.78)	0.296
3	-0.22 (-2.37, 1.93)	0.683
5%<aged above 65 years old≤10% (n=43)		
GDP per capita (log)	0.91 (-0.30, 2.12)	0.166
Population (log)	0.46 (0.12, 0.80)	0.018
Population density (log)	-0.17 (-0.73, 0.38)	0.570
Stringency index	-0.04 (-0.11, 0.03)	0.365
Proportion of female smokers (log)	-0.37 (-0.99, 0.25)	0.313
Proportion of male smokers	0.01 (-0.05, 0.06)	0.417
CVD death rate (log)	-1.2 (-3.43, 1.02)	0.389
Diabetes prevalence (log)	0.75 (-1.36, 2.87)	0.501
Testing policy		
0 (Ref)		
1	-2.01 (-3.26, -0.76)	0.033
2	-2.80 (-4.35, -1.25)	0.002
3	-3.36 (-6.62, -0.11)	0.061
10%<aged above 65 years old≤15% (n=26)		
GDP per capita (log)	0.42 (-0.97, 1.81)	0.554
Population (log)	0.12 (-0.21, 0.45)	0.644
Population density (log)	0.37 (-0.16, 0.9)	0.192
Stringency index	0.09 (0.03, 0.15)	0.053
Proportion of female smokers (log)	0.04 (-0.64, 0.73)	0.502
Proportion of male smokers	-0.10 (-0.16, -0.03)	0.027
CVD death rate (log)	2.27 (0.61, 3.92)	0.013
Diabetes prevalence (log)	0.23 (-1.55, 2.01)	0.716
Testing policy		
0 (Ref)		
1	-0.90 (-2.36, 0.56)	0.382

2	-3.72 (-5.61, -1.84)	0.001
3	-1.78 (-3.84, 0.29)	0.363
aged above 65 years old>15% (n=38)		
GDP per capita (log)	-5.27 (-9.93, -0.62)	0.031
Population (log)	1.03 (0.37, 1.70)	0.004
Population density (log)	1.26 (0.36, 2.17)	0.008
Stringency index	0.15 (-0.02, 0.31)	0.116
Proportion of female smokers (log)	7.21 (2.77, 11.66)	0.002
Proportion of male smokers	-0.32 (-0.52, -0.13)	0.002
CVD death rate (log)	-2.01 (-5.53, 1.52)	0.279
Diabetes prevalence (log)	-8.64 (-12.62, -4.65)	<0.001
Testing policy		
0 (Ref)		
1	1.47 (-1.57, 4.51)	0.347
2	1.60 (-1.77, 4.97)	0.356
3	4.28 (-0.48, 9.05)	0.105

Table S2. Estimation for variables' incidence rate ratio (IRR) for COVID-19 CDR

Variables	Unadjusted		Adjusted	
	IRR (95% CI)	P-value	IRR (95% CI)	P-value
Overall (n=209)				
GDP per capita (log)	1.69 (1.32, 2.16)	0.000	1.29 (0.93, 1.78)	0.186
Population (log)	1.10 (1.00, 1.22)	0.054	1.12 (1.02, 1.23)	0.023
Population density (log)	1.13 (0.96, 1.33)	0.202	1.08 (0.92, 1.27)	0.416
Stringency index	1.01 (0.99, 1.03)	0.475	1.01 (0.98, 1.03)	0.55
Proportion of female smokers (log)	1.31 (1.08, 1.59)	0.017	1.18 (0.96, 1.44)	0.162
Proportion of male smokers	0.99 (0.97, 1.01)	0.391	1 (0.98, 1.02)	0.587
CVD death rate (log)	0.24 (0.15, 0.41)	0.000	0.41 (0.2, 0.84)	0.046
Diabetes prevalence (log)	1.08 (0.64, 1.84)	0.520	1.08 (0.63, 1.86)	0.598
Testing policy				
0 (Ref)				
1	0.63 (0.37, 1.08)	0.116	0.59 (0.36, 0.97)	0.058
2	0.79 (0.43, 1.44)	0.438	0.66 (0.37, 1.18)	0.214
3	1.15 (0.45, 2.9)	0.566	0.74 (0.32, 1.74)	0.551
Low-income countries (n=29)				
GDP per capita (log)	0.54 (0.18, 1.61)	0.275	1.26 (0.41, 3.9)	0.711
Population (log)	0.69 (0.42, 1.12)	0.136	0.69 (0.43, 1.11)	0.134
Population density (log)	0.54 (0.35, 0.85)	0.017	0.82 (0.53, 1.29)	0.411
Stringency index	0.97 (0.93, 1.02)	0.265	0.99 (0.95, 1.04)	0.807
Proportion of female smokers (log)	1.61 (1.04, 2.48)	0.051	1.2 (0.67, 2.14)	0.469
Proportion of male smokers	1.02 (0.97, 1.07)	0.431	0.98 (0.91, 1.06)	0.502
CVD death rate (log)	16.09 (4.16, 62.28)	0.000	11.54 (1.73, 76.93)	0.014
Diabetes prevalence (log)	1.56 (0.58, 4.17)	0.392	0.89 (0.34, 2.35)	0.649
Testing policy				
0 (Ref)				
1	0.55 (0.24, 1.28)	0.183	0.71 (0.26, 1.95)	0.542
2	0.41 (0.09, 1.82)	0.288	0.61 (0.09, 3.95)	0.626
3	0.00 (0.00, inf)	0.990	0.00 (0.00, 0.00)	0.990
Lower-middle-income countries (n=44)				
GDP per capita (log)	0.9 (0.33, 2.47)	0.832	1.5 (0.57, 3.93)	0.461
Population (log)	0.85 (0.67, 1.07)	0.16	0.93 (0.72, 1.21)	0.63
Population density (log)	1.3 (0.88, 1.93)	0.197	1.25 (0.88, 1.79)	0.246
Stringency index	1.04 (0.99, 1.09)	0.094	1.03 (0.99, 1.09)	0.223
Proportion of female smokers (log)	1.45 (0.92, 2.28)	0.172	1.04 (0.69, 1.57)	0.633
Proportion of male smokers	0.99 (0.96, 1.02)	0.537	0.99 (0.96, 1.02)	0.367
CVD death rate (log)	0.56 (0.11, 2.75)	0.476	0.58 (0.14, 2.48)	0.485
Diabetes prevalence (log)	1.32 (0.52, 3.36)	0.573	1.93 (0.86, 4.31)	0.165
Testing policy				
0 (Ref)				
1	0.3 (0.12, 0.76)	0.027	0.32 (0.11, 0.93)	0.080

2	0.21 (0.07, 0.66)	0.016	0.17 (0.05, 0.61)	0.019
3	0.17 (0.03, 1.17)	0.076	0.08 (0.01, 0.75)	0.048
Upper-middle-income countries (n=54)				
GDP per capita (log)	2.25 (0.68, 7.49)	0.187	1.09 (0.34, 3.55)	0.579
Population (log)	1.44 (1.15, 1.8)	0.002	1.38 (1.03, 1.85)	0.046
Population density (log)	0.95 (0.67, 1.34)	0.749	0.94 (0.66, 1.33)	0.712
Stringency index	0.99 (0.95, 1.04)	0.676	0.98 (0.93, 1.02)	0.473
Proportion of female smokers (log)	1.09 (0.76, 1.57)	0.567	1.2 (0.86, 1.69)	0.295
Proportion of male smokers	0.97 (0.93, 1)	0.126	0.99 (0.95, 1.03)	0.58
CVD death rate (log)	0.25 (0.08, 0.84)	0.031	0.3 (0.09, 0.96)	0.077
Diabetes prevalence (log)	0.48 (0.13, 1.86)	0.305	0.77 (0.22, 2.72)	0.704
Testing policy				
0 (Ref)				
1	0.52 (0.21, 1.28)	0.230	0.57 (0.24, 1.34)	0.302
2	0.77 (0.26, 2.27)	0.450	0.74 (0.26, 2.09)	0.407
3	0.74 (0.06, 9.27)	0.816	0.49 (0.03, 7.19)	0.518
High-income countries (n=82)				
GDP per capita (log)	2.49 (0.98, 6.37)	0.126	2.52 (0.96, 6.59)	0.122
Population (log)	1.22 (1.07, 1.4)	0.004	1.19 (1.02, 1.39)	0.051
Population density (log)	1.11 (0.89, 1.4)	0.396	1.14 (0.89, 1.47)	0.353
Stringency index	1.03 (0.98, 1.08)	0.287	1.02 (0.96, 1.07)	0.552
Proportion of female smokers (log)	1.19 (0.8, 1.77)	0.372	0.97 (0.54, 1.74)	0.406
Proportion of male smokers	1 (0.96, 1.04)	0.596	1.00 (0.95, 1.05)	0.433
CVD death rate (log)	0.22 (0.09, 0.55)	0.006	0.5 (0.16, 1.6)	0.413
Diabetes prevalence (log)	0.58 (0.23, 1.47)	0.298	0.69 (0.21, 2.31)	0.567
Testing policy			2.52 (0.96, 6.59)	0.122
0 (Ref)				
1	0.81 (0.29, 2.28)	0.468	0.60 (0.24, 1.54)	0.449
2	0.67 (0.23, 1.97)	0.437	0.66 (0.25, 1.75)	0.376
3	1.08 (0.27, 4.3)	0.611	1.01 (0.28, 3.69)	0.619

GDP, gross domestic product; CVD, cardiovascular disease; CI, confidence interval.

Table S3. Estimation for variables' incidence rate ratio (IRR) for COVID-19 CDR by testing policy in upper-middle-income and high-income countries

Variables	Unadjusted		Adjusted	
	Beta (95% CI)	P-value	Beta (95% CI)	P-value
Testing policy=1 (tested only symptomatic & specified, n=45)				
GDP per capita (log)	2.28 (1.17, 4.46)	0.017	1.43 (0.68, 3.00)	0.354
Population (log)	1.16 (0.93, 1.46)	0.189	1.21 (0.96, 1.53)	0.114
Population density (log)	1.29 (0.96, 1.73)	0.096	1.11 (0.82, 1.49)	0.510
Stringency index	0.97 (0.92, 1.03)	0.312	0.99 (0.93, 1.05)	0.676
Proportion of female smokers (log)	1.01 (0.64, 1.59)	0.620	0.90 (0.53, 1.52)	0.606
Proportion of male smokers	0.95 (0.91, 0.99)	0.046	0.99 (0.94, 1.05)	0.646
CVD death rate (log)	0.22 (0.09, 0.53)	0.001	0.41 (0.13, 1.33)	0.157
Diabetes prevalence (log)	0.68 (0.21, 2.22)	0.520	0.94 (0.26, 3.42)	0.795
Testing policy=2 or 3 (tested anyone symptomatic or anyone public, n=37)				
GDP per capita (log)	2.84 (1.67, 4.84)	0.000	3.10 (1.50, 6.38)	0.007
Population (log)	1.08 (0.93, 1.25)	0.298	1.04 (0.84, 1.28)	0.722
Population density (log)	0.97 (0.75, 1.24)	0.777	0.93 (0.71, 1.21)	0.591
Stringency index	1.01 (0.97, 1.04)	0.776	1.02 (0.97, 1.08)	0.439
Proportion of female smokers (log)	1.06 (0.72, 1.57)	0.630	1.05 (0.65, 1.69)	0.578
Proportion of male smokers	0.98 (0.95, 1.02)	0.348	1.01 (0.96, 1.06)	0.634
CVD death rate (log)	0.42 (0.18, 0.95)	0.039	0.75 (0.24, 2.32)	0.629
Diabetes prevalence (log)	1.51 (0.46, 5.00)	0.502	1.73 (0.58, 5.13)	0.342

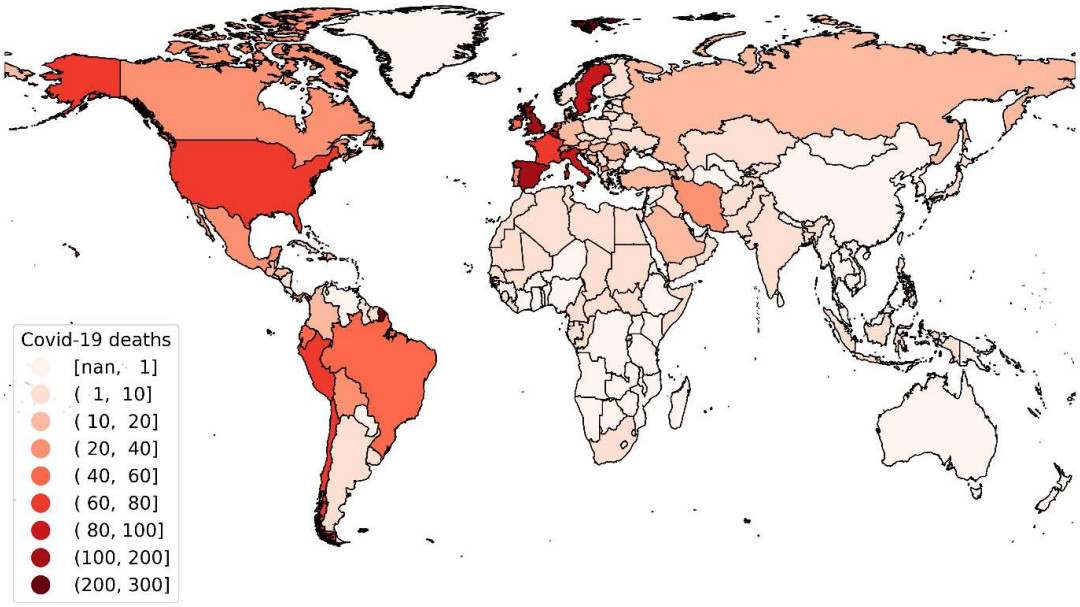

Figure S1. Global COVID-19 crude death rate (per 1,000,000 person-months)

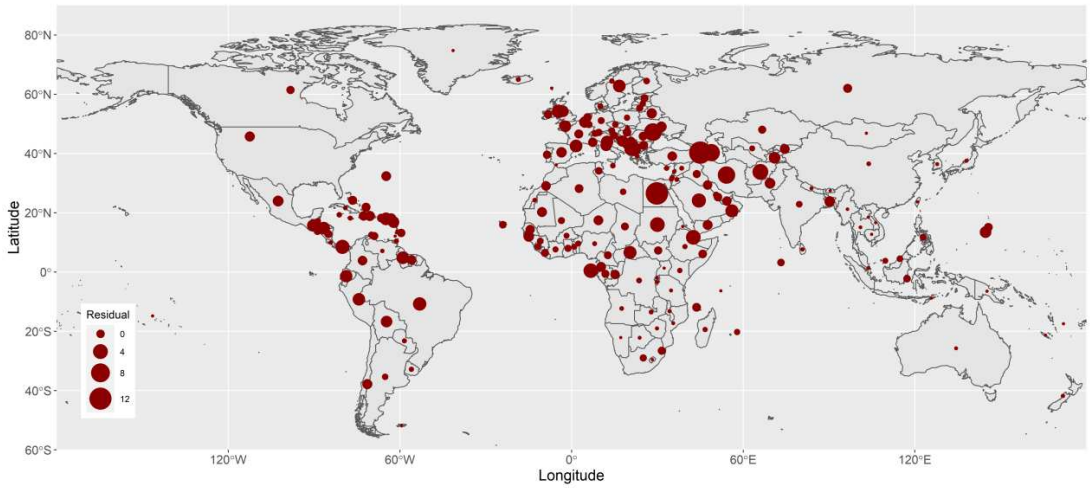

Figure S2. Residuals of COVID-19 crude death rate per 1,000,000 person-months based on the common (non-spatial) multivariate Poisson regression

The P-value from the Moran's I test for the spatial autocorrelation of the residuals < 0.001.

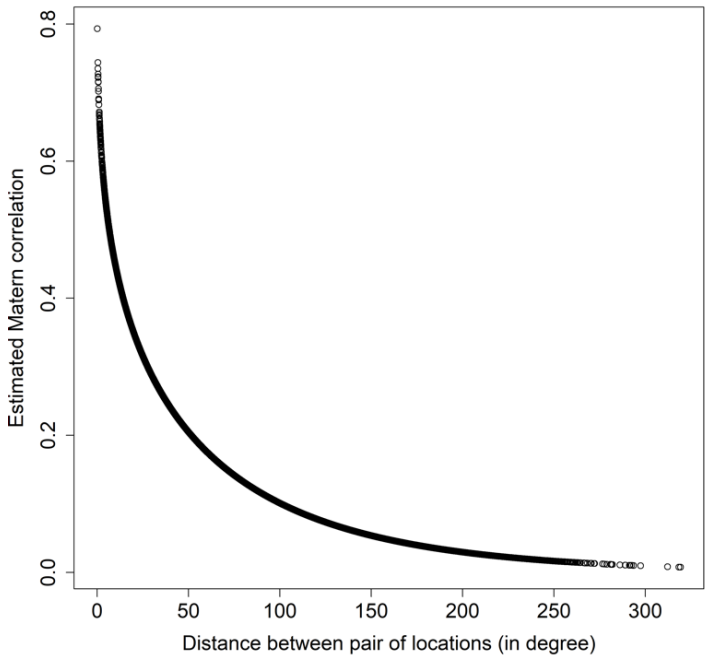

Figure S3. Strength and decay of the spatial autocorrelation between pair of locations (COVID-19 crude deaths per 1,000,000 person-months)

The estimated spatial autocorrelation coefficient of COVID-19 crude death rates between two locations against their distance is shown in Figure S3, with a strength parameter ν of 0.11 and a decay parameter ρ of 0.01.

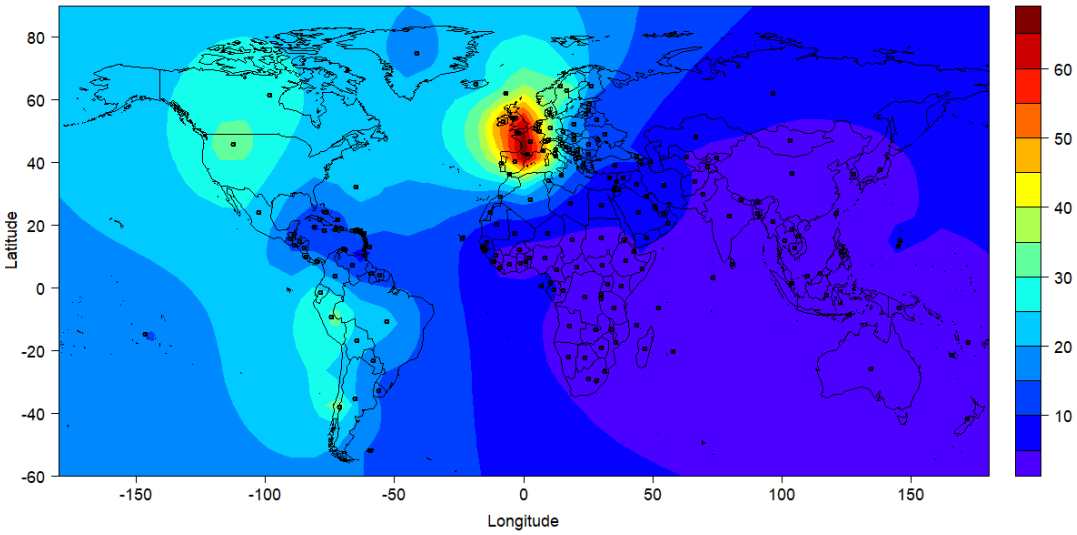

Figure S4. Contour plot of estimated COVID-19 deaths (per 1,000,000 person months)